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Extent of Processing Effect on the Proximate and Mineral Composition of African Breadfruit (Treculiaafricana) Seed

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Abstract:
The effect of three processing methods; parboiling, cooking and toasting on the proximate and mineral composition of raw African breadfruit were evaluated. Mean proximate contents of raw African breadfruit (%) were moisture (10.72), protein (20.01), fat (12.49), ash content (2.79), crude fibre (1.31), carbohydrate (52.69); while the extent of effect was on the decrease for moisture and protein (28.17 and 18.54%),(10.07 and 24.54%) and (36.57 and 10.04%) for parboiled, cooked and toasted samples respectively. Processing improved the fat, ash, crude fibre and carbohydrate contents except in the cooked sample that had a decreased extent of (18.89%) in fat content. Mean mineral contents (mg/100g) of the raw sample were copper (7.30), calcium (190), magnesium (95), iron (2.11), potassium (1480) and sodium (7.10). The extent of processing was on the decrease when compared to the raw except in potassium where toasting increased the value by (2.03%). The study showed that though affected nutrients (positively and negatively), the extent to which they are affected is important to enable proper selection of good processing method with least loss of nutrients.

Keywords: *African breadfruit, Treculia africana, mineral, toasting, parboiling, cooked*

1. Introduction

There is increased awareness of the importance of legumes in the diet of Nigerian populace. The main contribution of legumes to the diet of Nigerians is based on their nutritional values. African bread fruit (Treculia africana) is one of mankind's important sources of nutrients such as vitamins, carbohydrates, minerals, proteins and fat. African bread fruit is a very important indigenous fruit which generally play a vital role in the diet of man (Ejiofor *etal*, 1988).African breadfruit (Treculia africana) is a monoecious evergreen fruit belonging to the family of moraceae. Seed production of African bread fruit is considerable; a mature tree produces up to 30 fruits annually, each fruit yielding 5 - 10kg of seed after processing. The fruit contains black or brown seeds that can be peeled twice and cooked like chestnut (Agu and Akinjede, 2001). The seeds of bread fruit are rich in protein, fat, carbohydrate, and vitamins and eaten in many part of African (Kabuo, 2001). African breadfruit is a grain legume which is currently being considered as several sources of nutrient. It contributes immensely to the diet of Nigerians (Iwe and Ngoddy). The seed resemble the groundnut when roasted in flavour and uses and it may be processed into flour apart from being cooked and eaten as a main dish (Nwufor and Mba, 1988). The raw seed as well as the edible cotyledon are obtained after parboiling and dehulling. African breadfruit 'Ukwa' in Igbo Language is mostly consumed in Igboland and other parts of the southern states of Nigerian. During festive seasons, the rural homes use it as complementary foods to replace expensive foods. In Igboland and elsewhere, "Ukwa" is a free legume that produces fruits. The fruits are hung on the stem and branches and take about four months-to mature. Breadfruit seeds are used to prepare various traditional dishes. They could be roasted, consumed with soups, pound boiled or mashed to make pottage. Breadfruit is much more cherished and utilized in Igbo speaking part of Nigerian and other south east state. In other parts of Nigerian, the crop is not widely cherished due to ignorance of its nutritional potentials, processing preparation and utilization (Ajiwe *etal, 1995*).A major constraint in the utilization of African breadfruitis the difficult dehulling involved in the manual removal of the hulls from the parboiled seeds. This method is quite laborious, time consuming and does not favour effective utilization of the fruit. Another constraint is the long cooking time. Such long cooking time and high temperature can result to loss of flavour and nutrients (Ajiwe *etal, 1995*).Roasting and cooking are high temperature heat treatments of foods. All the major food processing treatment in current use, heat processing is the most encountered and it has a very important effect on various food components and quality. Depending on such factors as time, temperature, moisture content, presence or absence of reducing or oxidizing agents and. other ingredients such asacid, salt, sugars, fat, and other chemicals, heat treatment may have either beneficial or detrimental effects. Thus heat treatment on food must be carefully controlled to avoid or minimized damage to nutritive value, functionality, and sensory properties which determine acceptability. The aim of this study is to determine the extent of effect processing has on the proximate and mineral content of African breadfruit. The result of the study would be of value to consumers because it will create general awareness of the nutritional potentials of African breadfruit (Treculia africana) and the effects of the different processing methods by carefully controlling heat treatment to avoid or minimise damage to nutritive value, which determine acceptability (Obiakor-Okeke and Nnadi, 2014)

2. Materials and Methods

Procurement and processing of seeds: Mature African breadfruit seeds were purchased from Umuahia, Abia State. The seeds were authenticated at the Agronomy Department of the National Root Crop Research Institute (NRCRI) Umudike. The seeds were washed and sorted manually to remove bad seeds and other extraneous materials. The raw seeds of T. africana were divided into 4equal parts and each part processed by one of thefollowing methods: de-hulling and drying (raw), dehulling and parboiling, de-hulling and cooking, and toasting and de-hulling (Fig.1). De-hulling of seeds was done manually. Parboiling, cooking and toasting of seeds were done in tap water and fine sand respectively. Dryingof seeds (to a constant weight) was done under the sun for six to eight (6-8) hours. The processed seeds were each ground into fine powder using a laboratory mill and fractions of each were used for the analysis of their constituents.

Proximate analysis of processed seeds: Total ash content was determined by the furnace incineration method as described by James (1995). Crude protein content was determined using the Microkjedahl method (AOAC, 1990). Fat and crude fibre contents were determined the methods described by Pearson(1976). Carbohydrate content was estimated by difference.

Determination of minerals: Calcium and magnesium were determined by the methods described by James (1995). Iron, copper, potassium and sodium were determined by atomic absorption spectrophotometry as described also by James (1995).

Statistical analysis: Data generated from the study were analysed and the descriptive statistics presented as mean ± standard deviation of three determinations. Differences between means were separated using the ANOVA and multiple comparison tests, with the least significant difference fixed at 0.05. Analyses were done using the statistical software package SPSS for windows version 16.0 (SPSS Inc. Chicago IL).

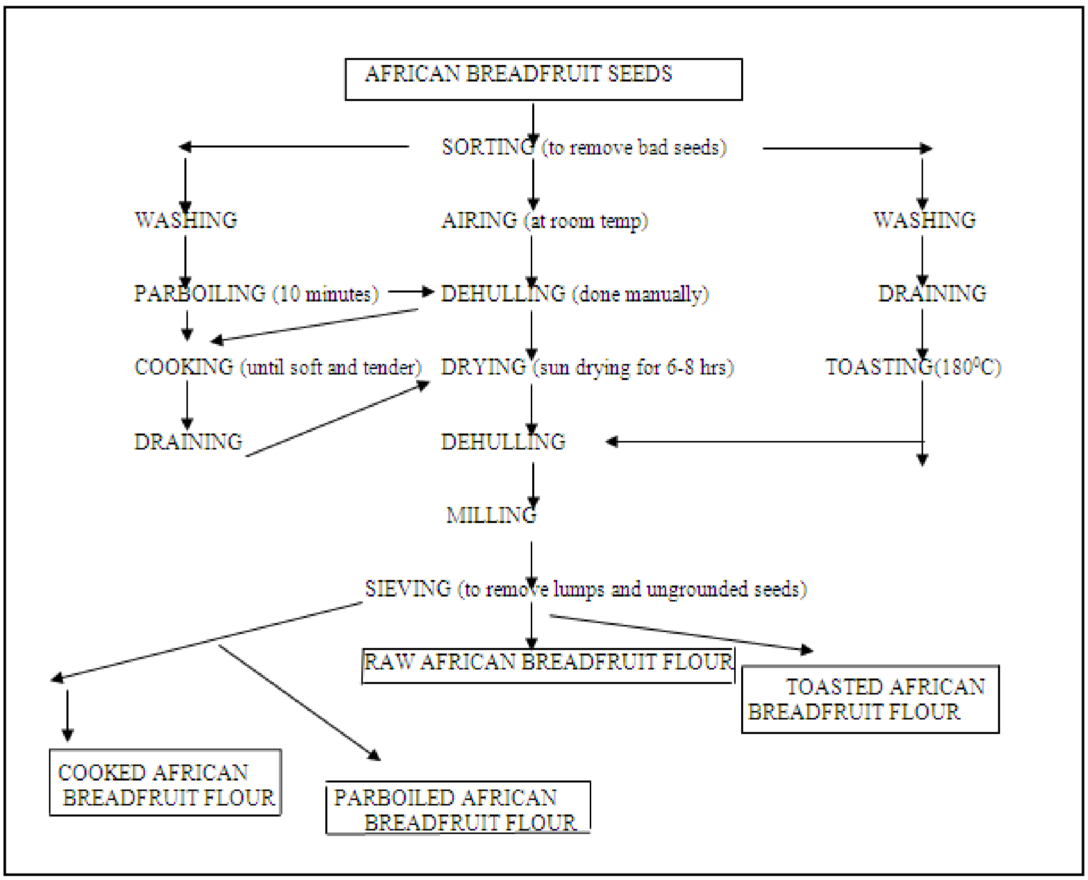

Figure 1: flow chart for the production of African breadfruit seed flour

3. Results and Discussions

Nutrient analyses of processed bread fruit samples indicate that the seeds of *T. africana* are rich in proteins and carbohydrates (Table 1). The moisture content of the samples varied significantly. The moisture content obtained in this study for the raw sample was higher than the report by Osabor *etal* (2009) and Nwabueze and Uchendu (2011). However, the value obtained from this study is in line with the report of Adedeji *etal* (2015) for shelf storage ability of flour. The protein contents obtained in this study compares well with that obtained by Ekpenyong (1985). The significant decrease in protein content of the cooked sample, could be attributed to denaturation of the endogenous proteins in the seeds during processing. The toasted sample had low carbohydrate content; this may be due to dehulling samples before further processing which was found to increase the carbohydrate contents of *T. africana* seeds but the toasted sample was toasted before dehulling. This could be indicative of the action of endogenous enzymes which may act to release bound carbohydrates from their complexes with non nutritive components of the seeds (Ugwu and Oranye, 2006).The lowering of fat content in the processed *T. africana* seeds could be attributed to losses during drying, cooking and toasting. The ash content in this study was on the increase in parboiled and toasted sample, but the cooked sample had the highest value; ash content is known to partly reflect the mineral composition (Umoh, 1998). The ash content obtained in this study is higher when compared with (2.26%) and (2.28%) reported by Osabor *etal* (2009) and Nwabueze and Uchendu (2011). The crude fibre content obtained in this study compares well with those reported by Lawal (1986). Processing resulted in a significant increase in crude fibre content of and parboiled, and cooked and toasted samples. This indicates that processing especially toasting of *T. africana* preserves the crude fibre content. This would be beneficial against colon cancers and also be useful in aiding bowel movement.

The extent of processing effect on the nutrients in Table 2 showed the extent of increase or decrease in the processed samples in comparison to the raw sample. The toasted sample had the highest reduction (36.57%) in moisture content. The extent of decrease in protein content was highest in the cooked sample (24.54%) and low in the toasted sample (10.04%). There was (30.02%) and (0.75%) increase in fat content in the toasted and parboiled samples, while the cooked sample had (18.89%) decrease. There was significant increase for ash content in the processed samples with the parboiled, cooked and toasted sample shaving (0.43%, 73% and 9.00%) increase respectively. The crude fibre obtained in this study had an increase in all processed samples with the parboiled and roasted samples having over 100% increases. As earlier reported processing resulted in a significant increase in the carbohydrate content of which the cooked sample had an increase of (14.31%).

Treatment	Raw seed	Parboiled seed	Cooked seed	Toasted seed
Parameters				
Moisture	$10.72^{a}\pm0.05$	$7.70^{c}\pm0.36$	$9.64^{b}\pm0.54$	$6.80^{d}\pm0.27$
Protein	$20.01^{a}\pm0.01$	$16.30^{c}\pm0.02$	$15.10^{d}\pm0.05$	$18.0^{b}\pm0.00$
Fat	$12.49^{c}\pm0.01$	$13.24^{b}\pm0.01$	$10.13^{d}\pm0.02$	$16.24^{a}\pm0.04$
Ash content	$2.79^{d}\pm0.01$	$3.22^{b}\pm0.02$	$3.52^{a}\pm0.02$	$2.88^{c}\pm0.02$
Crude fibre	$1.31^{d}\pm0.01$	$4.96^{b}\pm0.01$	$1.38^{c}\pm0.02$	$6.79^{a}\pm0.01$
Carbohydrate	$52.69^{b}\pm0.01$	$54.58^{b}\pm0.35$	$60.23^{a}\pm0.54$	$49.30^{c}\pm0.26$

Table 1: Effect of heat processing on proximate content of African Breadfruit Seed flour

Mean values in a row bearing different superscript are significantly different ($p<0.05$).

Treatment	Raw seed	Parboiled seed	Cooked seed	Toasted seed
Parameters		**(%)**	**(%)**	**(%)**
Moisture	10.72	28.17 (-)	10.07(-)	36.57(-)
Protein	20.01	18.54(-)	24.54(-)	10.04(-)
Fat	12.49	6.00 (+)	18.89 (-)	30.02(+)
Ash content	2.79	15.41(+)	73.00(+)	9.00(+)
Crude fibre	1.31	278.62(+)	5.34 (+)	418.32(+)
Carbohydrate	52.69	3.59 (+)	14.31(+)	6.82(-)

Table 2: Extent of processing effect on proximate content of African Breadfruit Seed flour
(-) negative effect *(+) positive effect*

3.1. Effect of heat processing on Mineral composition (mg/100g) of African breadfruit seed flour

The raw sample had a copper value of 7.30mg/100g; this is higher than the values (3.75mg/100g and 0.033mg/100g) reported by Abiodun and Umeonurah (2013) and Adumanya *etal* (2012). Copper decreased in all the processed samples with the parboiled sample having the least value (5.49mg/100g). Processing significantly reduced the quantities of calcium and magnesium in the seeds; the cooked sample had the least value of 64.67mg/100g and 32.33mg/100g respectively. This could be attributed to the leaching of these minerals in cooking water (Ijeh *etal*, 2010). Many neuromuscular and other cellular functions (like the signalling pathways) require calcium and the recommended calcium allowance for adolescents and adults is 1000- 1300mg/day (FAO/WHO, 2001). Magnesium functions as a co-factor of many enzymes in energy metabolism and biosynthesis of macromolecules, as well as contributes to the maintenance of the electrical potential of nervous tissues and cell membranes (Shils, 1988). The recommended nutrient intake of magnesium is 190-260mg/day for adolescents and adults (FAO/WHO, 2001). The levels of calcium and magnesium found in this study, though not enough to meet the recommended daily intakes, can nonetheless supplement other dietary sources of the minerals. Iron was highest in raw sample (2.11mg/100g) and lowest in cooked breadfruit sample (0.43mg/100g).this could be attributed to the leaching into cooking water as reported by Obiakor-Okeke and Nnadi (2014); the cooked water sample had a high value (10.00mg/100g). Potassium was highest in the roasted sample (1510mg/100g) and lowest in cooked sample (960mg/100g). The reason for the low mineral content in the cooked sample could be because most of the nutrient in the cooked African breadfruit must have leached out into the water, and it could be said that the nutrient content of breadfruit is bounded when unprocessed and unbounded when processed (Obiakor-Okeke and Nnadi, 2014). The sodium content of the raw African breadfruit corresponded with the (7.10mg/100g) reported by Osabor *etal,* (1995). The processed samples varied significantly with the cooked having the least value

(5.98mg/100g). Sodium is needed by the body for the maintenance of osmotic pressure, acid-base balance, absorption of glucose and transmission of impulse (Onimawo and Egbekun, 1998).

The extent of processing effect as shown in Table 4, describes the extent of effect processing had on the mineral content in comparison to the raw sample. There was decrease in copper value for all the processed samples, with the parboiled sample having a decrease to the extent of (24.79%) and the cooked sample having the least decrease of (18.22%); thus cooking can be said to retain more copper than other processing methods. The calcium and magnesium value for the processed samples decreased when compared to the raw sample. The extent of decrease was highest in the cooked sample (65.96%) for calcium and magnesium respectively. the roasted sample had a similar decreased extent of (62.10%); thus cooking and toasting affects calcium and magnesium more than parboiling does. Iron in this study was affected more by cooking and toasting. The extent of decrease was (79.62%) and (52.60%) respectively. the parboiled sample only had a decrease of (18.00%); thus parboiling method retains more iron content than cooking and toasting methods. Potassium was highest in the toasted sample which was (2.03%) higher than the raw sample. The extent of decrease varied in the parboiled and cooked samples (33.39%) and (35.13%) respectively. sodium was also affected in all the processed samples, the toasted sample was slightly affected (1.26%), while the cooked sample was affected more (15.77%). It can be said that toasting method retains more of the sodium content than parboiling and cooking methods.

Treatment	**Raw sample**	**Parboiled sample**	**Cooked sample**	**Toasted sample**
Parameter				
Copper	7.30^{a}±0.00	5.49^{d}±0.01	5.97^{b}±0.01	5.83^{c}±0.01
Calcium	190^{a}±0.00	140^{b}±0.00	64.67^{d}±0.01	72^{c}±1.00
Magnesium	95^{a}±1.00	70^{b}±1.00	32.33^{d}±0.01	36^{c}±1.00
Iron	2.11^{a}±0.01	1.73^{b}±0.01	0.43^{d}±0.01	1.00^{c}±0.01
Potassium	1480^{b}±2.00	986^{c}±1.00	960^{d}±1.00	1510^{a}±1.00
Sodium	7.10^{a}±0.05	6.75^{c}±0.05	5.98^{d}±0.01	7.01^{b}±0.01

Table 3: Effect of heat processing on Mineral composition (mg/100g) of African breadfruit seed flour

Mean values in a row bearing different superscript are significantly different ($p<0.05$)

Treatment	**Raw sample**	**Parboiled sample**	**Cooked sample**	**Toasted sample**
Parameter			**(mg/100g)**	
Copper	7.30^{a}±0.00	24.79(-)	18.22(-)	20.14(-)
Calcium	190^{a}±0.00	26.31(-)	65.96(-)	62.10(-)
Magnesium	95^{a}±1.00	26.31(-)	65.96(-)	62.10(-)
Iron	2.11^{a}±0.01	18.00(-)	79.62(-)	52.60(-)
Potassium	1480^{b}±2.00	33.39(-)	35.13(-)	2.03(+)
Sodium	7.10^{a}±0.05	4.93(-)	15.77(-)	1.26(-)

Table 4: Extent of processing Effect on Mineral composition (mg/100g) of African breadfruit seed flour
(-) negative effect (+) positive effect

4. Conclusion

The study shows that processing affected African breadfruit (*Treculia africana*) seed in that moisture was reduced in the processed sample which is good to improve the storage ability of the flour. Processing also affected protein content, though the extent of loss in the toasted sample is minimal. Parboiling and toasting increased fat content of the African breadfruit seed. Processing increased the contents of ash, crude fibre and carbohydrate in varying extents except for toasting which reduced the carbohydrate content. Parboiling of African breadfruit seeds resulted in less percentage loss of calcium, magnesium and iron content. Cooking resulted to less percentage decrease in copper, while toasting resulted to less percentage loss of potassium and sodium.

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